NISEB Journal Vol. 16, No. 4, December, 2016 1595-6938/2016
Printed in Nigeria (2016) Society for Experimental Biology of Nigeria
http://www.nisebjournal.org

Development and Production of Snack from *Clarias gariepinus* (Burchell 1822) and *Ipomea batatas* (L.) Lam

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Abstract
A new type of food was produced from Clarias gariepinus and Ipomea batatas called fish snack. Fillets were made from catfish and spiced using a combination of garlic, onion, pepper and ginger. The spiced fillets were smoked-dried using a combination of smoking kiln and multipurpose dryer. Sweet potato flakes were produced from the fresh tubers by pre-gelatinization and dehydration. Moisture and oil content, peroxide value and organoleptic assessment was conducted on the snack containing fish fillets and sweet potato flakes before packaging in a polythene bag. The snack was stored for three months at an average temperature and relative humidity of 28^{o}C and 80 % respectively. Shelf-life study for three months showed an increase in moisture content and peroxide values of fish fillets from an initial value of 5.96% -10.30% and 0.98% -2.86% respectively. Moisture content of potato flakes also increased from an initial value of 3.80% - 8.67%. However, oil content value of the fillets reduced from 20.01% - 19.19%. The microbial count results were below the safe limit. The overall assessment of the organoleptic quality of the snack was considered good which showed no significant difference ($p>0.05$) compared to the initial. Significant differences ($p<0.05$) existed between the data obtained for the chemical parameters, but were still within the safe limits. The result show that the product is acceptable and safe for consumption in the third month and this product is expected to offer a new variety of snack and also add value to the fish and potato food chain.
Keywords: snack, organoleptic, fish fillets, potato flakes, moisture

Introduction
Fish is an important source of food and income to many people in the developing world. Fish provides a good source of high quality protein, vitamins and minerals. However, fresh fish is highly susceptible to deterioration soon after harvest without any processing and preservation. An estimate of 40 % post-harvest losses of total fish handlings have been reported in Nigeria (1). Catfish (*Clarias gariepinus* (Burchell 1822) is a very important freshwater fish in Nigeria. It has enjoyed wide acceptability in most parts of the country because of its unique taste, flavour and good texture (2). It is highly nutritious containing 19.64 % protein, lipid 1.15 %, moisture 76.71 % and ash 1.23 % with some amount of polysaturated and unsaturated fatty acids, mineral and vitamins (3, 4). Potato (*Ipomea batatas)* is the most important food crop in the world after wheat, rice and maize. It contributes to almost 50 % of the total tuber and root crop production. Potato has a good food value as compared to other staple food crops as it is rich in carbohydrates. Potato also contains protein, calcium, potassium and vitamin C. Also, potato contains no saturated fats or cholesterol; but it is a rich source of dietary fiber, anti-oxidants, vitamins, and minerals. They are good for diabetic patients as its glycemic index is low (5). The present crave for consumption of fast food in Nigeria is on the increase. The aim of this project therefore is to produce a nutritious, safe and acceptable snack from *C. gariepinus* and *I. batatas*.

Materials and Methods
Source of materials
C. gariepinus used were freshly harvested from a fish pond in Abule Ijesha area of Yaba, Lagos while wholesome *I. batatas*, spices (salt, ginger, pepper, garlic, onion) and charcoal were obtained from Bariga Market in Lagos. A set of kitchen knives, electric oven, multipurpose produce dryer, smoking kiln and fish box all designed and fabricated by NSPRI.

Procedure for filleting and dehydration
Four live catfish of 14.6 kilogram weight were harvested, transported in NSPRI fish box containing ice and taken to the fish processing centre. The fish were subjected to pre-smoking treatment; thawing, washing, gutting and filleting. Filleting was carried out using a sharp thin knife. It involves cutting along the backbone to remove the hard skin giving a skinless and boneless tissue of less than 4mm in thickness. The fillets were washed under running tap, drained and covered to prevent contamination. The drained filets were weighed and spiced using pepper 6.8 %, ginger 22.6 %, onion 45.2 % , garlic 11.3 %, salt 11.3 % and seasoning 2.8 %.The spiced fillets

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were arranged in trays and placed in the heated smoking kiln powered with charcoal. The fish fillets were smoked at 90 ^{o}C for 2 h 30 m using 2.55 kg of charcoal. The spiced smoked fillets were transferred to a multipurpose dryer at temperature ranging between 50-60 ^{o}C for about 18 h using 2.58 litres of kerosene. This process yielded spiced, smoked dry fish fillets which were allowed to cool and packed in an airtight container for further use. Wholesome sweet potato tubers were washed under running tap repeatedly and peeled. The peeled tubers were then sliced to the desired size and washed again .The sliced sweet potato were soaked in metabisulphite for 10 minutes for colour retention before pre gelatinization for 5 minutes to reduce its starch content . The pre gelatinized sliced potato flakes were dehydrated in an oven at 55 ^{o}C for 20 h. Dehydrated potato flakes were allowed to cool and packed in an airtight container for further use. Spiced smoked dry fillets and potato flakes were packaged together in 0.1 mm (100 micrometer) thick polythene bag.

Chemical Analyses

The following analyses were carried out on the fish snack before packaging and during storage. These include moisture content, oil content and peroxide value.

Moisture Content

Moisture content was determined using standard method. This involves oven drying of 5 g of smoked fish at 103°C until a constant weight was attained (6).

Oil content

Oil was exhaustively extracted using 5.0 g of smoked fish in a Soxhlet apparatus with petroleum ether (boiling point range 40-60^{o}C) as the solvent (6). The oil content was determined by the following formula: % oil = (weight of oil/original weight of sample) x 100.

Peroxide Value

The peroxide value was also determined by using 5g of extracted oil into acetic acid- chloroform in ratio 3:2.The titrimetric method was carried out by adding 2 drops of starch solution to 0.5ml potassium iodide solution in 30ml of acetic acid-chloroform solution which was titrated against 0.1N sodium thiosulphate solution to a blue colour end-point indicator (6)

Organoleptic Assessment

Organoleptic assessment of the spiced smoked dry fish fillets and dehydrated potato flakes was carried out by trained panelist of ten (10) people comprising of 5 males and 5 females drawn from staff of NSPRI Lagos Zonal Office. They were made to identify two unlabeled solutions of sugar and salt to ascertain the accuracy of their taste buds. The panel assessed the attributes such as appearance, aroma, taste, fragmentation, colour and odour of the fish fillets and dehydrated potato flakes in separate instances: the attributes were scored on five (5) point Likert's scale of summation. The mean of 3.0 and above was considered good (7)

Microbial evaluation

Culture and non-culture dependent methods were used for microbial analysis (8).

Statistical Analysis

Data obtained were subjected to statistical analysis using SPSS. V. 20. Differences between means and levels of significance of the data were determined using Duncan Multiple Range Test (DMRT) at 5% level of significance.

Results and Discussion

From Table 1-2, results of the shelf-life of the snack containing spiced smoked dry fish fillets and the potato flakes for three months showed an increase in moisture content and peroxide value. The oil content of the spiced smoked dry fillets decreased over the same period. The moisture content of spiced smoked fillet and potato flakes increased from an initial value of 5.96% -10.30% and 3.80% - 8.67% respectively. PV of extracted oil from the spiced smoked fillets increased from 0.98% -2.86% and the oil content of the spiced smoked dry fillets reduced from 20.01% - 19.19% during the same period of storage. All these changes were statistically significant ($p<0.05$).

Plate 1: Fish snack made from C. gariepinus and I. batatas

Table 1: Moisture content, oil content and peroxide value of spiced, smoked dry catfish fillets

Months	Moisture Content Value	Oil content value	Peroxide value
0	5.96±0.01[a]	20.01±0.01[a]	0.98±0.01[a]
1	6.12±0.01[b]	19.79±0.01[b]	1.78±0.01[b]
2	7.70±0.01[c]	19.27±0.01[c]	2.30±0.10[c]
3	10.30±0.10[d]	19.19±0.01[d]	2.86±0.01[d]

Means with different superscripts on the same column show significant difference at p<0.05.

Table 2: Moisture content of dehydrated potato flakes

Months	Moisture Content Value
0	3.80±0.10[a]
1	5.60±0.10[b]
2	7.72±0.01[c]
3	8.67±0.01[d]

Means with different superscripts on the same column show significant difference at p<0.05.

From table 3-5, results of organoleptic evaluation of spiced smoked fillets, potato flakes and combination of both showed that the scores for texture, taste, colour, odour were all acceptable (4.8-4.0) with no significant difference except appearance ($p<0.05$).

The scores odour, taste and texture were acceptable (5.0-3.4) for the dehydrated potato flakes however were significant ($p<0.05$) while appearance, colour and fragmentation were not significant ($p>0.05$).

Overall, all the attributes scores were above the cutoff point and this showed that the snack was acceptable at the third month of storage after production

The increase in moisture content of the fish snacks from the initial 5.96 % to 10.30 % over a period of three months of storage can be attributed to absorption of moisture from the surrounding, (Table 1). Moisture content of 12 % is the level beyond which fish products begin to grow moulds after few days (9). From table 1, the oil content of the fish snack is 20.01 % which suggests that the fish snack contain a high amount of oil. It was reported that smoking resulted in concentration of nutrients like crude fat (10). More so, the high oil content could possibly be due to the type of feed they consume and oil storage mechanism of the cultured specie (since they might not use their oil reserve during spawning as opposed to the uncultured ones). Also, it was observed that the oil content of the fish snack decreased from 20.01 - 19.19 % over the same period of storage. This can be attributed to reduction in lipid content due to oxidation of poly-unsaturated fatty acids (PUFA) contained in the fish tissue to products such as peroxides, aldehydes ketones and the free fatty acids though it was gradual and did not reflect in the taste (11). The peroxide value (0.98 -2.86%) was well below the recommended limit of between 10- 20 meq/kg (12). This could be attributed to the anti-oxidative properties of the combination of onion, garlic and ginger used in spicing the fillets as affirmed by various authors on the use of individual spices (2, 13).

The moisture content of the dehydrated spiced potato flakes increased from 3.80 -8.76 % over a period of three months of storage. This is due to the absorption of moisture relative to the environment (Table 2). However with the increase in moisture content of the flakes, it appears crispy. Moisture content of 9-12 % has been suggested by some studies as the level of storage for dehydrated potato flakes (14).

The organoleptic results obtained for the fish snack indicated good overall acceptability with scores above the cutoff point of 3.0. Acceptability of spiced smoked catfish as a whole or fillets has reported which agreed with this study (2, 15). Many factors influence the quality of smoked fish products including the properties of fish flesh, maturity, age, sex, seasonal variations and factors involved in the smoking procedure such as wood type, composition of smoke, temperature, humidity, velocity and density of the smoke (16). Phenolic and carbonyl compounds contribute towards taste in smoked fish. It is assumed that reactions between the carbonyl compounds and proteins are mainly responsible for colour formation on smoked surfaces whilst the absorbed phenolic compounds are related to flavor and aroma of the smoked product. Fish also differ in flavour owing to a variety of volatile compounds. The organoleptic responses observed were combination of any of these factors (15).

Organoleptic results obtained from the storage of dehydrated sweet potato flakes were acceptable with score above cutoff of 3.0 which is similar to results obtained by (17).

They indicated that dehydrated sweet potato flakes can be held in residential storage for a period of 5 years with 50 % acceptance for daily use and greater than 50 % acceptance for emergency use at 30 years of storage. Dehydrated potato flakes appear to retain quality to warrant long term storage.

Table 3: Organoleptic assessment of spiced smoked dry catfish fillets stored for three months

Months	Appearance	Texture	Taste	Colour	Odour	Fragmentation
Initial	4.4±0.55^{a}	4.8±0.45^{a}	4.8±0.45^{a}	4.8±0.45^{a}	4.4±0.55^{a}	4.0±0.71^{a}
First	3.8±0.45^{a}	4.0±0.71^{a}	4.6±0.55^{a}	4.2±0.84^{ab}	4.3±0.58^{a}	4.5±0.89^{a}
Second	4.6±0.55^{a}	4.8±0.45^{a}	3.8±0.45^{b}	4.2±0.45^{ab}	4.8±0.45a	4.6±0.55^{a}
Third	2.8±0.84^{b}	4.2±0.84^{a}	3.2±0.84^{b}	4.0±0.55^{ab}	3.4±1.14^{b}	4.4±0.89^{a}

Means with different superscripts on the same column show significant difference at p<0.05.

Table 4: Organoleptic assessment of dehydrated potato flakes stored for three months

Months	Appearance	Texture	Taste	Colour	Odour	Fragmentation
Initial	4.6±0.55^{a}	4.2±0.71^{a}	4.8±0.45^{a}	4.4±0.55^{a}	4.4±0.55^{a}	5.0±0.00^{a}
First	4.4±0.55^{a}	4.0±0.71^{a}	4.8±0.45^{a}	3.8±0.55^{a}	4.2±0.30^{a}	4.6±0.84^{a}
Second	4.0±0.71^{a}	3.8±0.45^{a}	4.0±0.71^{b}	3.4±0.45^{a}	4.0±0.71^{a}	4.4±0.55^{a}
Third	3.2±1.00^{a}	3.0±0.84^{b}	2.8±0.45^{c}	3.4±1.10^{a}	3.4±0.84^{b}	4.0±0.89^{a}

Means with different superscripts on the same column show significant difference at p<0.05.

Table 5: Organoleptic Assessment of Fish Snack stored for three months

Months	Appearance	Texture	Taste	Colour	Odour
Initial	4.50±0.01^{a}	4.5±0.06^{a}	4.8±0.00^{a}	4.4±0.55^{a}	4.4±0.02^{a}
First	4.10±0.05^{a}	4.3±0.00^{a}	4.7±0.01^{a}	3.8±0.55^{a}	4.4±0.00^{a}
Second	4.3±0.04^{a}	4.0±0.08^{a}	4.0±0.10^{b}	3.8±0.03^{a}	4.3±0.01^{a}
Third	3.0±0.00^{b}	3.6±0.40^{b}	3.8±0.00^{b}	3.4±0.00^{a}	3.5±0.04^{b}

Means with different superscripts on the same column show significant difference at p<0.05.

Microbial result did not show the presence of pathogenic organisms and the total plate counts were below the safe limit of 10×10^{3} cfu/g. This clearly shows that the snack is safe for consumption.

Table 6: Microbial results of fish snack stored for three months

Months	TAC (cfu/g)	Coliform	Salmonella	Shigella	*E.coli*
Initial	6×10^{2}	Nil	Nil	Nil	Nil
First	10×10^{2}	Nil	Nil	Nil	Nil
Second	16×10^{2}	Nil	Nil	Nil	Nil
Third	16×10^{2}	Nil	Nil	Nil	Nil

TAC- Total Aerobic Count, cfu/g- coliform forming unit per gram, Nil - No growth,

Conclusion

Results obtained from fish snack have shown that the product is safe, nutritious and highly acceptable. It is a value-added product and its subsequent introduction into the local and international markets will enhance the nutritional intake of households and increase the income of fish and potato farmers. Therefore, production of fish snack from fish fillets and dehydrated sweet potato flake is a good development that should be encouraged.

Recommendation

Fish snack containing potato flakes being a ready food should be given appropriate marketing strategies to make it available for travellers and consumers. Local processor of fish should be trained on production and packagings of fish snack. There is also a need to determine the complete nutritional composition, oil profile and organoleptic quality for a longer period.

Acknowledgement

This project was supported by West African Agricultural Productivity Programme (WAAPP). Also, the authors thank Messrs Olatunde I.G., Ihionu, G.C., Usanga E.O., Udefi S.I. and Mrs. O.R. Abiose for their effort**.**

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